ESTIMATING THE VERTICAL DISTRIBUTION OF NEAR-SURFACE ICE USING THE COMPTONIZED CONTINUUM FROM THE NEUTRON-CAPTURE GAMMA-RAY LINE. D. M. Smith, *Space Sciences Laboratory, University of California, Berkeley, Berkeley CA 94720-7450, USA, (dsmith@ssl.berkeley.edu).*

Boynton et al. [Science, v.297, p.81, 2002] have studied the global distribution and depth profile of water ice on Mars with the Mars Odyssey gamma and neutron spectrometers via three parameters: the fluxes of the 2.223 MeV gamma-ray line from neutron capture on hydrogen, and thermal and epithermal neutrons. We will report on the first attempt to add another constraint on the depth profile by measuring the 2.223 MeV photons which Compton scatter in the overlying material before reaching the spacecraft. For a given form of the vertical distribution, the size of this continuum tail below the line constrains one parameter: for example, for a model with a dry dust layer over a deep layer with uniform ice content, the thickness of the dust layer is directly related to the flux in the tail. This technique was used by Vestrand et al. [Proc. 21st ICRC, v.5, p.160, 1990] to measure the depth at which neutron capture on hydrogen was occuring in the solar atmosphere during a large solar flare.

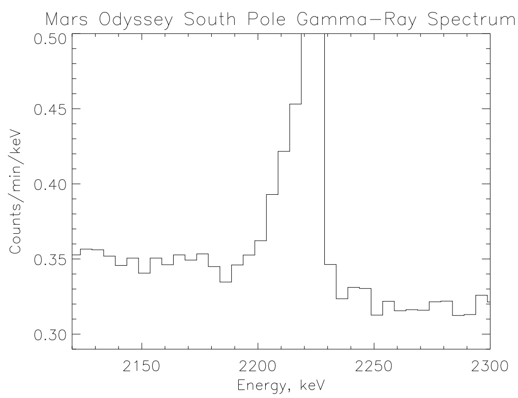

Figure 1: Mars Odyssey gamma-ray spectrum accumulated for Southern latitudes, from Boynton et al. 2002.

Figure 1 shows a close-up of the previously published Mars Odyssey gamma-ray spectrum for latitudes less than –60 degrees [Boynton et al. 2002, ibid.]. There is clearly a step in the continuum across the line. To determine how much is due to Compton scattering of 2.223 MeV photons on the planet, the shape of the underlying spectrum (background and planetary) must be understood well. In addition, the response of the detector to incoming un-Comptonized photons must be understood in detail, since both Compton scattering in the instrument and the effect of radiation damage to the detector both produce tails below the photopeak. Figures 2 and 3 show preliminary results of the simulations we will be using to model these effects. Figure 2 shows three simulations using the GEANT3 package of Compton scattering in both the planet (using the crude vertical profile mentioned above) and the instrument. Figure 3 shows simulations of radiation damage due to hole trapping in the Mars Odyssey coaxial germanium detector. These simulations allow us to characterize the full spectral shape of the radiation-damage tail with a single parameter.

Using these simulations, we can easily remove the contributions from radiation damage and scattering in the instrument. By using data from the whole planet, including regions not rich in hydrogen, and by incorporating data from later in the mission when the spectrometer was already extended on its boom, we can estimate the spectral shape in the energy band of Figure 1 due to background and planetary contributions unrelated to hydrogen. With all these components removed, we will use further GEANT3 simulations (e.g. Figure 2) to compare the observed step with various near-surface ice distributions. The technique should be generally applicable to upcoming missions that may see a hydrogen line from planetary surfaces, such as the Messenger and BepiColumbo missions to Mercury, and may even be extendable to bright lines from other elements.

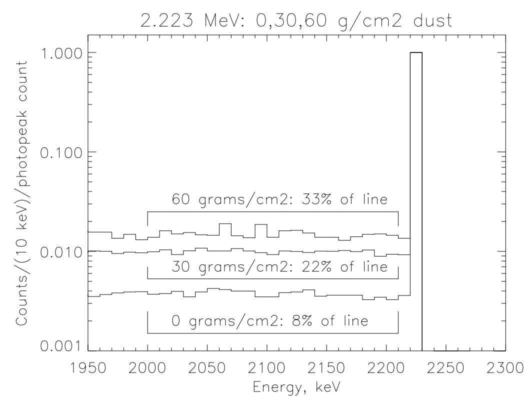

Figure 2: Simulated Compton tails due to varying levels of overlying ice-free dust for an otherwise uniform distribution of near-surface ice.

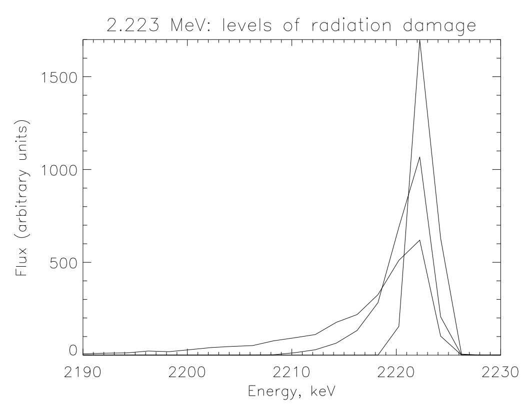

Figure 3: Simulated lineshapes due to varying levels of radiation damage in the Mars Odyssey coaxial germanium detector.